The extraordinary role of viruses in the evolution of all life on earth

Definitions

- *Gene* = protein coding = 1.2% of DNA. Exons/introns/*transposons*. RNA.
- *Regulatory gene*.
- *Retrovirus* (RNA with own enzyme)
- *Endogenous retrovirus* = inherited. —This is how viruses transfer genes between species and provide us with entirely new genes, and mix up the regulatory genes to create new forms of animals.
- *Symbiosis* (clean stations, lichens)
- *Endosymbiosis*

The world is FULL of viruses (orchestrating everything)

(1) QUOTE ZIMMER

(2) OUR DNA IS FULL OF VIRUSES -- DIAGRAM

Viruses are the living ancestors of all life

READ ZIMMER - LAST PAGE, then from Lane ***(very quickly)***:

- Vents (photos) produced nucleotides that accumulated to extreme levels, silting up the pores.
- The vents then mass-produced RNA (natural PCR from thermal cycling). Small RNAs replicated.
- The genetic code itself shows its origin out of the central metabolic chemistry of all life, so we now know metabolism came first.
- So the unit of natural selection was the replicating small RNAs together with the metabolizing "rock-cell."
- DNA was recruited to allow complexity, and to unite a cooperating population of virus-like RNAs
- So retroviruses are our ancestors and ongoing partners in evolution. They should be recognized as "alive."
- VIRUS CONTRIBUTIONS – internal membranes, nuclear pores, motivation to separate from the rock "hatchery". Introns - 3 per gene – mix and match makes 3X number of genes. Originated as a defense against virus invasion of the DNA – introns are spliced out using molecular scissors taken from the jumping gene viruses themselves. Then nucleus membrane barrier was needed to separate the two stages of splicing and translating into proteins. So viruses were primary cause of all animal and plant life.

Animal life driven by viruses

Scenario 1: A slug that eats photosynthetic bacteria and incorporates the bacteria's chloroplasts into its own cells. Stops eating, solar powered, plant-animal. The slug

has transferred key genes from the bacteria, in order to maintain the chloroplasts. Second level: the gene transfer is made possible by an endogenous retrovirus that uses the slug to reproduce and then kills off the slugs after their eggs are laid.

Scenario 2: wasp eggs in caterpillar have virus that takes over host immune system and hormones to produce a "brood chamber".

Scenario 3: Plant experiment – virus in fungus in plant, heat tolerance.

Endosymbiosis, whole system a holobiont. Co-evolved as a system, inseparable. "Organisms are metabolic nets, accepting help from other life forms."

Plagues and pandemics as symbiotic co-evolution

AIDS retrovirus: SIV is the same virus as HIV 1 (chimps) & 2 (monkeys). Difference is that in chimps it's old. Chimps are symbiotic with the virus because they get the trait of being able to wipe out competitors in their niche that are closely related species. Another example is grey squirrel, which wipes out the red squirrel with pox virus (carried in their DNA like a weapon). The victim species gets culled by the plague and survivors now have the weapon and sometimes other traits as well. AIDS virus will probably become endogenous and harmless in 100 years. This process is why we have 4X virus genes as vertebrate genes; AIDS just latest in long series.

Koala bears—leukemia epidemic, ERV 100 years, seeing it in process before nonvirulent—same fossil virus in other classes much earlier.

Viruses as creative driving force of evolution (symbiogenesis)

Virus genes are a huge resource completely different from cellular genes, mixing and matching mainly between other viruses. Gives huge "pre-adapted" potential driving force for fast evolution.

"Viruses and the Evolution of Life" L.P. Villarreal 2005 – major transitions to vertebrate, mammal, and primate correspond to explosions of retrovirus lineages.

DNA transposons—40 families highly active during mammalian radiation and early primate evolution, then "mass extinction" in human ancestor. Recent "great HERV colonization", ancient turf wars, plaque culling, "sculpting us."

Many viral genes are now used to control gene expression (regulatory genes). Example: (1) viruses compete with each other and some protect the human fetus, (2) some physiological functions on Y chomosome. (3) one type creates the placenta (protect against mother's immune system)—a synsytium—in primates; highly conserved. Different mammals have different sets of viruses contributing to creating the placenta. So viruses are the originating cause of the various classes of placental mammals!